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(71) Applicant: VALMET OY [FI/FI]; Punanotkonkatu 2, SF-00130 Helsinki (FI).

(72) Inventor: MALASHENKO, Alexander ; 1147 Woodside Dr., Dollard des Ormeaux, Quebec H9B 1R1 (CA).

(74) Agent: FORSSÉN & SALOMAA OY; Uudenmaankatu 40 A, SF-00120 Helsinki (FI).

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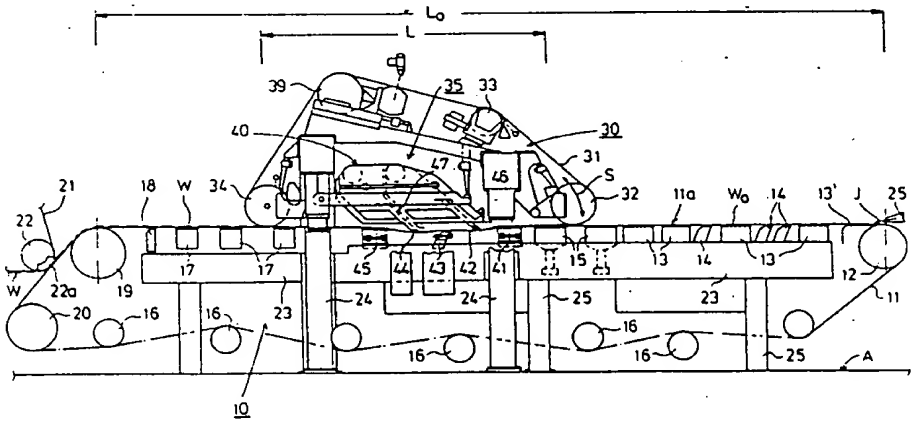


(57) Abstract

Procedure in the forming of a paper web and in dewatering the paper pulp suspension. A pulp suspension jet (J) is supplied onto a lower wire (11), water is drained through the lower wire (11), the fibre pulp course (W_o) is conducted into a dewatering and forming zone (L), where water is drained through the wires (11, 31) and the web (W) is conducted onto a pick-up fabric (21). In the forming zone, the joint run of the wires (11, 31) is deflected, a dewatering effect is caused such that water escapes from the pulpe course (W_o) only through the upper wire (31), a change of direction of the run of the wires (11, 31) is caused in the opposite direction, water that has escaped through the upper wire (31) is collected and said water is guided to water collecting means (40, 46), the run of the twin-wire part is deflected in a direction opposite to preceding deflection; and the joint run of the wires (11, 31) and of the pulp course conforms, starting from the single-wire initial part (11a), to sinusoidal path, the ratio of this wave's length λ to the amplitude H of the wave being in the range λ/H = 12 to 20. The invention also concerns an upper wire unit (30), with ancillary equipment (41, 43, 45) for remodelling the Fourdrinier wire section of a paper machine.

Procedure and means for improving the papermaking process on a Fourdrinier wire section

The present invention concerns a procedure in the forming of a paper web, in particular of newsprint of fine paper, and in dewatering the paper pulp suspension, in said procedure:

the fibre suspension jet being directed on a lower wire from the lip slice of the headbox,

water being drained from the pulp course through the horizontally planar lower wire by gravity action and by utilizing dewatering elements in such manner that the pulp course attains a dry matter content of preferably about 1.0 to 1.5 %,

said fibre pulp course being conducted into a twin-wire dewatering and forming zone between said lower wire and a particular upper wire, where water is drained from the fibre pulp course both through said lower wire, in with particular, through said upper wire by the effect of dewatering elements,

the web being separated from said upper wire and kept supported by the lower wire, on which it is conducted onto a pick-up fabric.

The invention moreover concerns an upper wire unit ancillary equipment, intended for modernizing the Fourdrinier wire section of a paper machine, said unit comprising a frame structure and an upper wire loop guided by guide rolls mounted in support of said frame, one of them a breast roll, and by stationary shoe members, said upper wire loop cooperating with the lower wire loop belonging to said Fourdrinier wire section, on part of the length of this lower wire loop, so that the upper wire loop and the lower wire loop have a joint run in the region of which water is drained from the water-containing fibre course that has been conducted in between said wires and has been formed on the initial portion of the lower loop before said joint run, both through the upper wire in particu-

lar and through the lower wire, substantially by utilizing stationary shoe members, of which part have been placed inside the upper wire loop and another part inside the lower wire loop, of said shoe members those having an odd ordinal number as counted in the direction of travel of the web being placed inside the lower wire loop, respectively those with an even number being placed inside the upper wire loop.

Most paper brands - for instance newsprint or letterprint papers - are manufactured of fibres derived from wood. The papermaking process, as a broad concept, comprises the pretreatment of the fibres before the paper machine; thereafter the partial processes taking place on the paper machine, such as web forming, compression treatment of the web and web drying; and finally web reeling and an after-treatment step. The present invention is confined to the web forming process taking place on the wire section.

The structure and operation of a Fourdrinier wire section are known from before to a person skilled in the art and therefore no more detailed description thereof is required in this connection. It may be observed, in the way of background of the present invention, that the operation of a planar wire section and its effect on the paper quality no longer, in modern high-speed paper machines, meet those requirements which are imposed by papermakers on the production of the paper machines and by the paper users on the quality characteristics of the paper. As regards the wire section of a paper machine, it is expected that it is able ever more efficiently to dewater the pulp suspension that has been supplied onto the wire and thereby to render feasible a continuous, high working speed of the paper machine. It is expected, at the same time, that the enhanced dewatering action has no detrimental effect on certain characteristics of the paper, such as its formation or its onesidedness.

In some instances, e.g. when remodelling a planar wire section, no attempt whatsoever is made to increase the speed of the paper machine, the sole aim of remodelling being to improve the paper

quality, for instance as regards the characteristics mentioned.

Thus, in connection with the disclosure of the present invention, the papermaking process is understood to mean the dewatering process taking place on the Fourdrinier wire section and, in connection and association with the dewatering process, the web formation, that is, the positions which the fibres assume in relation to each other.

The object of the present invention is to achieve an improvement of the web forming process taking place on the wire section of a paper machine. One of the aims is to increase the amount of draining taking place on the wire section, particularly that which is directed upward, this circumstance having the effect of improving the paper quality on the whole and, particularly, its symmetry and its printing properties.

Increasing the dewatering rate, or the dewatering capacity of the wire section, mostly implies that the speed of the paper machine can be increased and thereby also the production of the paper machine can be augmented. However, if increasing the speed of the machine is not feasible, due to mechanical reasons for instance, it is possible, at all events, to achieve savings in the consumption of thermal energy in drying the paper.

In the first place, the invention is meant for application in remodelling existing paper machines. It is endeavoured to make maximal use of existing structures. It is a particular aim to retain the frame of the wire section of the old paper machine as it is.

One more object which is being aimed at with the aid of the present invention is to improve the so-called formation. The formation is said to be poor if one can see in the paper that the fibres are unevenly built up on the surface of the paper and that they are present in the shape of a cloudy formation. Correspondingly, if no such clouds can be observed when viewing the paper against a light,

or if they are few, the formation is said to be good. As taught by the present invention, the formation is being acted on by directing on the pulp course that is being formed between the wires, a varying dewatering effect which shall be more closely described later on.

In order to achieve the aims stated above, and others which will become apparent later on, the procedure of the invention is mainly characterized in that in said twin-wire forming zone are performed the following web forming and dewatering operations, in sequential order as stated:-

(a) the joint run of said wires is gently deflected with the aid of a first forming shoe, provided with a substantially solid cover, disposed inside the lower wire loop and thereby causing, through higher tension-induced pressure from the upper wire and through the change of direction of the wires, a dewatering effect such that water is drained in considerable amount from the pulp course through the upper wire, while the substantial draining through the lower wire is inhibited at this time,

(b) with a second shoe member, substantially narrower than the first forming shoe, disposed inside the upper wire loop is caused a gentle, opposite change of direction of the joint run of the wires,

(c) a doctor member located on the leading edge of said second shoe member, or in its vicinity, is used to collect water that has been drained through the upper wire, and said water is guided, at least partially utilizing its kinetic energy, into water collecting boxes disposed inside the upper wire loop,

(d) with a shoe member disposed inside the lower wire loop, or with an equivalent suction box, or suction boxes, the run of the twin-wire portion is deflected in the direction opposite to that of the preceding change of direction, and

(e) the dewatering actions as specified under (a) to (d) being so

arranged that the joint run of the wires and the pulp course interposed between them conforms, starting tangentially from the single-wire initial portion, at least in its initial part to a substantially sinusoidal path having a wavelength of which the ratio to the amplitude H of the wave is in the range λ/H = 10 to 25, preferably in the range λ/H = 12 to 20.

The means applying the procedure of the invention, again, is mainly characterized in that the joint run of said upper and lower wire loops starts in the region of the first shoe member and that the line adjacent to the solid cover of the first shoe member where the upper wire and lower wire are tangent to each other has been arranged to be adjustable by raising or lowering the breast roll of the upper wire for controlling the amount of that draining which takes place by effect of the first, solid shoe member and through the upper wire;

that said shoe members in the twin-wire forming zone have been disposed horizontally preferably with substantially uniform spacing one after the other, and in the height direction placed in such manner that the twin-wire portion is by effect of said shoe members guided to run below the original plane of the twin-wire part's upper run along a substantially sinusoidal path having a wavelength λ of which the ratio to the wave's amplitude H is in the range λ/H = 10 to 25, preferably λ/H = 12 to 20; and

that said wavelength λ is within the range λ= 500 to 1000 mm and said amplitude H is in the range H = 35 to 60 mm, preferably H = 40 to 50 mm.

The aims of the invention are achieved mainly in that upon an existing Fourdrinier wire section is mounted a so-called upper wire unit, by using which a certain part of the paper forming process will take place between two wires. The web forming process taking place between two wires implies that the water escapes, from the web being formed in this region, mainly upward but also downward. Exactly, this feature causes faster dewatering, owing to

which it is possible to increase the speed of the machine. On the other hand, if the speed of the machine is substantially unchanged, this enhancement of dewatering can be utilized in the way that on the web that is in the process of being formed is directed a comparatively mild draining pressure, whereby the fine fibres and fillers in the web will less than before escape from the web structure, compared with their depletion during fairly violent dewatering. This entails a considerable improvement of the paper's printability, owing to the increased opacity caused by the fines which the paper contains.

The circumstance that draining takes place in two directions affects the printability of the paper in another way, too. It is an obvious consequence of dewatering taking place in two directions that both surfaces of the finished paper will be more closely equal, compared with the case in which dewatering would only take place in one direction.

In the invention, so-called shoe members are employed as structural components mainly influencing the operation of the upper wire unit, such members being placed both inside the upper wire loop and inside the Fourdrinier lower wire loop, in the twin-wire forming zone. The general principle is that the changes of direction caused by the shoes in the run of the wires are minimal. The gentle change of direction caused by one shoe totals about 8 to 12° at most. With the shoes inside the upper wire loop is connected a water collecting means to carry off the water which is drained upward.

Judging from preliminary experience gained with the Applicant's experimental paper machine, the adequate number of said shoes is usually four, at the most, when the speed of the paper machine is about 800 m/min. It goes without saying that the invention is not confined to any given number of shoes: shoes may be left out as well as added. As a rule, more shoes are needed at high machine speeds.

The greater part of the draining through the upper wire is effected,

in the invention, in the region of the first solid-cover shoe inside the lower wire loop, the extent of this shoe's action sector being preferably adjustable by setting the position of the wire guide roll (the breast roll). The breadth of the first shoe is usually about 300-500 mm. The first shoe is usually provided with a substantially solid cover, and the radius of curvature of its cover is preferably about R_1= 3000 mm.

In the invention, the wire guide roll which guides the upper wire into the region of the first shoe is preferably adjustable as to its position, mainly vertically. As a result, the coverage by the upper wire in the region of the first shoe becomes adjustable. Adjustment of this coverage may also be accomplished by moving the shoe, most appropriately by tilting the shoe. The purpose with the first shoe is to achieve a change of direction in the dewatering action taking place on the Fourdrinier wire section. To this end, the shoe preferably has a smooth surface and a solid cover, and at this shoe the upper wire and lower wire are pressed together, whereby the pressure thus generated will force the water escaping from the fibre course to go upwards, expressly through the upper wire.

After the first shoe just described follows another shoe, narrower than the first and located inside the upper wire loop, and to which has been connected a water collection duct for carrying off the water departing in the region of the first shoe. The distance between the trailing edge of the first and the leading edge of the second shoe is preferably about 100 to 300 mm, most preferably about 150 to 200 mm. If this distance is excessively large, the result is that the water cannot sufficiently be conducted to the water collection duct and it departs downward instead.

The invention is described in the following in greater detail, with reference being made to certain embodiment examples of the invention, presented in the figures of the attached drawing, but to the details of which the invention is in no way narrowly confined.

Fig. 1 presents, in schematical elevational view, a Fourdrinier wire section which has been remodelled to apply the procedure of the invention.

Fig. 2 presents the upper wire unit of the invention, in schematical elevational view.

Fig. 3 presents, in schematic elevational view, another forming section conforming to the invention.

As shown in Fig. 1, the Fourdrinier planar wire unit 10 to be remodelled and improved comprises a frame part, consisting of horizontal beams 23 and upright beams 24 and 25. The planar wire loop 11 passes, starting at the breast roll 12, in the horizontal plane on its run T-T, where inside the wire loop has been provided an assembly of dewatering equipment known in itself in the art, comprising the breast table 13', the planar suction boxes 13,15 and 17, and the foils 14,18. On the downwardly inclined run between the rolls 19 and 20, the web W is detached from the wire 11 and transferred onto the pick-up felt 21 by effect of the suction zone 22a of the pick-up roll 22. The return run of the wire 11 is guided by the guide rolls 16.

As was observed already, there has been a recent increase in remodelling jobs on planar wire sections which aim either at an improvement of the paper's quality characteristics and/or at an increase of the production rate of the paper machine. In these endeavours, and in the other applications of the invention, there is disposed, as shown in Fig. 1 above the Fourdrinier wire unit 10 and substantially coinciding with its centre, an upper wire unit 30, of which the frame part 35 rests on the upright beams 24. The parameters which have an influence on the operation of the upper wire unit 30 are best seen in Fig. 2. When using the upper wire unit 30 of the invention, only minor modifications of the Fourdrinier planar wire section are necessary, and most equipment items belonging thereto remain as they are. The changes are restricting to removing in the central region of the planar wire section 10, for instance, three

consecutive planar suction boxes and mounting in their place, in the direction of travel of the wire 11, first a forming shoe 41 with smooth surface and solid cover and having a comparatively large radius of curvature R_1 and, on the trailing side, a forming shoe provided with a lath cover 36, its cover having a large radius of curvature R_5 and its interior volume connected to a source of suction, or vacuum, (-P). Halfway between said shoes 41 and 45 with curved surface (R_1'R_5), inside the loop of the wire 11, is disposed a narrower shoe 43, which may resemble a foil. The guiding top surface of the centremost shoe 43 preferably lies at a small distance H, below the tangent plane of the shoes 41 and 45.

The wire loop 31 of the upper wire unit 30 is guided by the guide rolls 32,33 and 34. The latter of the guide rolls 34, at least, is provided with a drive 35. The guide rolls 32,33 and 34 are provided with doctor blades 37 in a manner known in itself in the art. Inside the loop 31 of the upper wire has been disposed, as a compact unit, a dewatering box 40 on the lower side of which have been integrated narrow, lath-like shoes 42 and 44 guiding the run of the twin-wire forming zone and which come to lie substantially halfway between the corresponding dewatering elements 41,43 and 45 of the lower wire unit. It is thus understood that the distances L_1'L_2'L_3 and L_4 between the shoes 41,42,43,44 and 45 operating in the twin-wire forming zone, which are added in connection with remodelling, are preferably all substantially equal. The radii of curvature R_1'R_2'R_3 and R_4 are usually in the range from 2000 to 4000 mm, preferably about 3000 mm.

One of the most important modes of action of the invention is that the direction of the draining taking place on the initial, single-wire part through the wire 11 is inverted, that is, changed into dewatering going upwards through the wire 31. To this end, the first shoe 41 has a solid cover, whereby the water is forced to depart in the direction of the arrows F_2' through the upper wire. The dewatering taking place in the region of the first shoe 41 accounts for the major part, for instance about 90 %, of the dewatering taking place on the twin-wire portion. The dewatering in

the region of the first shoe 41, through the upper wire 31, is highly significant in view of the overall functioning of the forming section. It is therefore appropriate to make this contribution to the dewatering action such that it can be regulated. To this end, the guide roll 32 of the upper wire 31 has been made adjustable in the direction of the arrow S, mainly in the vertical plane, so that the joint coverage angle a of the twin-wire portion and the shoe 41 is changed. The larger the angle a, the higher is the contribution of dewatering through the upper wire 31, on the first shoe 41. If, for instance, the radius of curvature of the first shoe 41 R_1 = 3000 mm and its breadth lo is 300 to 500 mm, the angle a is, for instance, in the range a = 2 to 12°. With a view to adjusting said coverage angle a, the first shoe 41 may also be arranged to be tiltable, that is to be turnable about its longitudinal axis, or even to be movable horizontally and/or vertically. A design solution has already been worked out for the apparatus required in this connection, in the same Applicant's Finnish Patent No. 62873 (equivalent to U.S. Patent No. 4,416,731).

As taught by the invention, the course of the twin-wire forming zone, which is confined between the lines K_1'K_2 (Fig. 2), is slightly, mainly sinusoidally, undulating so that the amplitude H of the wave is in the range H = 35 to 60 mm, preferably H = 40 to 50 mm. The course of the twin-wire part begins on the solid-cover forming shoe 41, the tangential plane on its leading edge 41' being the original plane T-T of the planar wire. Hereafter, the twin-wire zone curves downwards, guided by the shoe 42, whereafter it curves upwards again, guided by the narrow shoe 43 located inside the lower wire unit 10. Hereafter, the course of the wires 11,31 curves downward, guided by the narrow shoe 44 of the upper wire unit 30, ending up in the original plane T-T, guided by the shoe 45 with lath cover 46. Although the shoes 42,43 and 44 are rather narrow in the direction in which the wires proceed, the twin-wire part on the whole becomes smoothly, substantially sinusoidally undulating, owing to the dynamic forces. The dewatering pressure acting in the region of the shoe 41 in the twin-wire forming zone amounts, as is well known, to $P_1 = T_2/R_1$, where T_2 is the tension (in N/m) of the

upper wire 31. Similarly, the dewatering pressure acting in the region of the shoe 42 is $P_2 = T_1/R_2$, (T_1 = tension (in N/m) of the lower wire). The dewatering pressure acting in the region of the shoe 43 is $P_3 = T_2/R_3$. The dewatering pressure acting in the region of the shoe 44 is $P_4 = T_2/R_4$ and the dewatering pressure acting in the vicinity of the initial edge of the shoe 45, $P_5 = T_2/R_5$. The tensions T_1 and T_4 42 are preferably in the range 5 to 8 kN/m and the radii of curvature R_1,R_2,R_3 and R_4, in the order of 3000 mm.

In Fig. 3 is presented an alternative embodiment of the invention, appropriate e.g. for use with comparatively thin brands of paper. The embodiment of Fig. 3 differs from that of Fig. 1, first, in that its upper wire unit 30 has been placed rather close to the headbox 25. Therefore, the single-wire initial part 10a constituted by the lower wire 11 will be comparatively short, so that in its region there are only two breast tables 13" or equivalent, over one of them already being located the breast roll 32 of the upper wire 31, this breast roll being adjustable in the vertical direction S. As shown in Fig. 3, there are only two forming shoes on the twin-wire portion: a comparatively wide first, solid-cover shoe 41, which accomplishes the remarkably high amount of dewatering in the direction of the arrow F_1 through the upper wire 31 and into the box 40'. Since on the relatively short single-wire initial part 10a rather much water has still been left undrained, the proportion of dewatering taking place in the region of the shoe 41 is higher than mentioned above. In conjunction with the dewatering box 40', there is a second shoe 42, substantially narrower than the first shoe 41, which is lath-like and causes a "dip" in the course of the wires 11 and 31. Hereafter, there are found on the twin-wire portion, against the lower wire, the suction boxes 46, in the region of which the joint run of the wires 11 and 31 returns quite gently to the plane T-T of the upper wire and which further complete the dewatering action. In the region of the latter box 46 and of the planar suction box 47 following thereafter, the upper wire 31 separates from the lower wire. The planar suction box 17' makes sure that the web W follows along with the lower wire 11. In other respects, the structure and operation of the forming section de-

picted in Fig. 3 are mainly similar to those described before in connection with Figs 1 and 2. In Fig. 3, the planar suction boxes 46' are largely equivalent to the forming shoe 45 with lath cover, presented in Figs 1 and 2.

In the following are described the main features of the operation of the forming section of the invention and the influence exerted thereon by various parameters. The operation of the planar wire part 10 is normal on the single-wire initial portion 11a. The headbox 25 supplies the fibre suspension jet J onto the planar wire part at the wire table 13', in the region of this table and thereafter water being drained from the web mainly by gravity action only and assisted by the dewatering equipment 13,14,15. The upper wire unit 30 and the twin-wire forming zone defined by it have been so placed that on the start line K_1 of the twin-wire part the dry matter content of the fibre course W_o that has been formed is in the order 1 to 1.5 %. If the dry matter content of the fibre course is substantially higher than this value when the fibre course arrives in the sphere of action of the upper wire unit 30, the aims of the present invention cannot be achieved, not in all parts at least. Above all, this concerns the effect of the upper wire unit 30 on the symmetry and formation of the web that is being formed.

In the twin-wire forming zone K_1-K_2, to begin with, the leading edge of the shoe 41 drains water minimally in the direction of the arrow F_1 by doctor action. In the region of the shoe 41, and in the region between it and the foil lath 42, water escapes in remarkable quantity in the direction of the arrow F_2, primarily owing to the tension pressure P_1 from the upper wire 31, and assisted by centrifugal force. The waters departing through the upper wire in the direction of the arrow F_1 are conducted, partly by effect of the water's kinetic energy (auto-slice effect) and partly by effect of the vacuum (-P) in the water collection box 40, through the passage 46 in the direction of the arrow V into the box 40, and thence further to one side of the paper machine. In the region of the shoe 42, the tension pressure P_2 between the wires 11,31 is

primarily determined by the tension T_1 of the planar wire 11, whereby dewatering mainly takes place in the direction of the arrow F_3. The leading edges of the shoes 42,43 and 44 may also have a doctor effect, which drains water to some extent. In the sphere of action of the shoe 43 provided in conjunction with the lower wire unit 10, the tension pressure between the wires 11 and 31 is determined by the tension T_2 of the upper wire 31, causing dewatering in the direction of the arrow F_4, this being promoted by the doctor effect of the leading edge of the last foil 44. The waters thus escaping are transported by kinetic energy and by vacuum effect (-P) through the passage 47 and by mediation of the box 40 to one side of the wire section. In the sphere of action of the shoe 44, the tension pressure is determined by the tension T_1 of the lower wire 11 and in the region of the shoe 45, by the tension T_2 of the upper between the laths 46 of the shoe 45 drains water and, above all, makes sure that the web W follows along with the planar wire 11 as the upper wire 31 separates therefrom.

In Fig. 1, the upper wire unit 30 has been placed in the central region of the length L_o of the planar wire. In embodiments like that of Fig. 1, the length L of the twin-wire part, relative to the total length L_o of the planar wire, depends on many different factors, for instance on whether the purpose of remodelling is mainly to increase the speed of the forming section or mainly to improve the web formation, i.e., to influence the quality characteristics of the paper. In embodiments like that of Fig. 1, the proportion of the length L in relation to the length L_o is in the range 25 to 40 %, preferably in the range 30-35 %.

As regards the dewatering contributions, about 85 to 95 % of the total dewatering take place on the single-wire initial portion 11a, preferably about 90 %. The dewatering taking place in the twin-wire dewatering zone K_1-K_2 is most properly distributed so that the contribution to the total dewatering on the twin-wire part of the dewatering in the direction of the arrow F_2 through the upper wire is very high, about 80 to 95 %, preferably about 90 %. The contribution of the dewatering in the direction of the

arrow F_3 through the lower wire is 5 % and that of the dewatering in the direction of the arrow F_4, relative to the dewatering taking place in the region L, is in the order of 10 %, the rest being distributed among the other contributions.

The embodiments presented in the foregoing in Figs 2 and 3 differ in the respect that in Fig. 2 there are two waves in the twin-wire dewatering zone, produced under guidance by the shoes 41,42,43,44 and 45, the first such wave having the length $L_1 + L_2$ and the second wave having the length $L_3 + L_4$. There is only one "wave" in Fig. 3, its length being mainly determined by the shoes 41 and 42.

As taught by the invention, the course of the twin-wire run is substantially sinusoidal at the shoes which guide it. It is highly important in view of the aims of the invention that the shape of said sine wave is appropriately gentle. This circumstance is best expressed by the ratio $f = \lambda/H$, where λ = the wavelength, (peak-to-peak) and H is the amplitude of the wave (the difference in height between peak and valley). In view of the aims of the invention, this ratio is f = 10 to 25, preferably 12 to 20. The length λ of said wave is most properly in the range λ = 500 to 1000 mm and the amplitude in the range about 35 to 60 mm, preferably about 40-50 mm. The run of the twin-wire zone deviates somewhat from a sinusoidal wave, in the first place because in the embodiment of Figs 1 and 2 the first and last shoes, 41 and 45, are substantially wider than the second, third and fourth shoes 42,43 and 44.

It is also essential in the invention that said undulating twin-wire forming zone is below the base level T-T of the lower wire in its entirety, preferably even so that the guiding surface of the narrow central shoe 43 lies a small distance H_1 below the plane T-T.

In the following are stated the claims, various details of the invention being allowed to vary within the scope of the inventive idea thereby defined and to deviate from what has been presented above.

Claims

1. A procedure in the forming of a paper web, in particular of newsprint or fine paper, and in dewatering the paper pulp suspension, wherein:

a pulp suspension jet (J) is supplied onto a lower wire (11) from the lip slice of a headbox (25);

water is drained from the pulp course through the lower wire (11) lying in a horizontal plane, by gravity action and by utilizing dewatering elements (13,13',13",14,15), in such manner that the pulp course (V_o) attains, preferably, a dry matter content of about 1.0 to 1.5 %;

said fibre pulp course (V_o) is conducted into a twin-wire dewatering and forming zone (L) between said lower wire (11) and a particular upper wire (13), where water is drained from the fibre pulp course both through said lower wire (11) and, above all, through said upper wire (11,31) by the effect of dewatering elements (41,42,43, 44,45,46);

the web (W) is separated from said upper wire (31) and kept supported by the lower wire (11), where it is conducted onto a pick-up fabric (21),

characterized in that in said twin-wire (11,31) forming zone are accomplished the following web formation and dewatering actions, in the order as specified:

(a) the joint run of said wires (11,31) is gently deflected with a first forming shoe (41) with substantially solid cover placed inside the lower wire loop (11) and hereby is caused, by effect of the tension pressure (P_1) of the upper wire (31) and by the change of direction (R_1) of the wires (11,31), a dewatering effect such that water escapes in remarkable quantity from the pulp course (W_o) through the upper wire (31), while the substantial dewatering

taking place through the lower wire (11) is inhibited at this time;

(b) with a second shoe member (42), substantially narrower than the first forming shoe (41), placed inside the upper wire loop (31) is caused a change of direction of the joint run of the wires (11,31) in the opposite direction;

(c) with a doctor member on the leading edge of said second shoe member (42) or adjacent thereto is collected water that has escaped through the upper wire (31) and said water is guided, partly at least utilizing its kinetic energy, to water collecting means (40,46) provided inside the upper wire loop (31);

(d) with a shoe member (43) or an equivalent suction box, or suction boxes, (46) provided inside the lower wire loop (11) (Fig. 3) the run of the twin-wire part is deflected in a direction opposite to the preceding deflection; and

(e) the dewatering actions of (a) to (d) being so arranged that the joint run of the wires (11,31) and of the pulp course interposed therebetween conforms, starting tangentially from the single-wire initial part (11a), to a gently undulating path, substantially sinusoidal in its initial part at least, the ratio of this wave's length to the amplitude H of the wabe being in the range λ/H = 10 to 25, preferably in the range λ/H = 12 to 20.

2. Procedure according to claim 1, characterized in that:

with a narrow shoe member (44) disposed inside the upper wire loop (31) after said narrow shoe member (43) is deflected the course of the wires (11,31) in the direction opposite to the direction of the deflection by the preceding shoe member (43);

with the aid of a doctor member on the leading edge of said narrow shoe member (43) or adjacent thereto is collected water, that has escaped through the upper wire (31), which is carried further with the aid of dewatering elements (40,47);

with a second broad shoe member (45) located after the last-mentioned narrow shoe member (44) is deflected the joint run of the wires (11,31) in the direction opposite to the preceding change of direction and the run is returned to the original plane (T-T) of the lower wire (11);

and the above-mentioned shoe members (41,42,43,44,45) guiding the joint run of the wires (11,31) in the twin-wire zone, which are preferably uniformly spaced, are arranged to guide the twin-wire forming shoe along a gently undulating, substantially sinusoidal path, starting at the single-wire initial part (11a) of the lower wire (11) and ending up in the original plane (T-T) of the lower wire, so that said undulating path lies entirely below the plane (T-T).

3. Procedure according to claim 1 or 2, characterized in that in the procedure the contribution of the dewatering taking place through the upper wire in the region of the first shoe member is regulated by adjusting the preceding breast roll (32) of the upper wire as to its position, mainly vertically (S).

4. Procedure according to any one of claims 1 to 3, characterized in that the contribution of the dewatering taking place through the upper wire (31) by effect of the first solid shoe member (41) to the dewatering taking place in the twin-wire forming zone (L) is in the order of about 85 to 95 %, preferably about 90 %.

5. Upper wire unit (30), with ancillary equipment (41,43,45), for remodelling the Fourdrinier wire section of a paper machine, said unit (30) comprising a frame structure (35) and an upper wire (31) loop guided by guide rolls (32,33,34) mounted on its support, whereof one is a breast roll (32), and by stationary shoe members this loop cooperating with the loop of the lower wire (11) belonging to said Fourdrinier wire section on a part (L) of this lower wire loop's length (L_0) so that the upper wire loop (31) and the lower wire loop (11) have a joint run, in the region of which water is

drained from the water-containing fibre course (W_o) conducted in between said wires (11,31), which has been formed on the initial part (11a) of the lower wire (11) before said joint run, both predominantly through the upper wire (31) and through the lower wire (11) substantially by utilizing stationary shoe members (41, 42,43,44,45,46'), of which part have been disposed inside the upper wire loop (31) and another part inside the lower wire loop (11), of said shoe members (41,42,43,44,45) those having an odd ordinal number as counted in the direction of travel of the wires being placed inside the lower wire loop (11), respectively those with even number, inside the upper wire loop (31),

characterized in that:

the joint run of said upper and lower wire loops (11,31) begins in the region of said first shoe member (41) and that the line (K_1) at the solid cover of the first shoe member (41) where the upper wire (31) and the lower wire (11) are tangent to each other has been arranged to be adjustable by raising or lowering (S) the breast roll (32) or equivalent member of the upper wire (31) in order to control the quantity of the dewatering taking place by effect of the first solid shoe member (41) through the upper wire (31);

said shoe members (41,42,43,44,45) and equivalent (46) in the twin-wire (11,31) forming zone have been disposed with substantially uniform horizontal spacing after each other and so located in the height direction that the twin-wire part is by effect of said shoe members guided to run below the original plane (T-T) of the planar wire section's upper run along a substantially sinusoidal undulating path, the ratio of this wave's length λ to the amplitude H of the wave being in the range λ/H = 10 to 25, preferably λ/H = 12 to 20; and

said wavelength λ is in the range λ = 500 to 1000 mm and said amplitude H is in the range H = 35 to 60 mm, preferably H = 40 to 50 mm.

6. Upper wire unit according to claim 5, characterized in that the adjustment of the line of contact (K_1) between the upper and lower wires (11,31) requisite for controlling the quantity of dewatering taking place in the region of the first solid-cover shoe (41) has been totally or partly provided for by adjusting the transversal tilt, in relation to the direction of travel of the wire (11), of said shoe member and/or the position in height and/or the lateral position of said shoe member (41).

7. Upper wire unit according to claim 5 or 6, characterized in that the breadth (L_{10}) in the direction of travel of the wires (11,31) of the first shoe member (41) is in the range Ll_0 = 350 to 500 mm.

8. Upper wire unit according to any one of claims 5 to 7, characterized in that said second shoe member (42) consists of at least one lath of width about 50 to 100 mm.

9. Upper wire unit according to any one of claims 5 to 8, characterized in that said second shoe member (42) has been connected to a water collection passage (46), which is upwardly inclined in relation to the direction of travel of the wires, and to a water removal means (40).

10. Upper wire unit according to any one of claims 5 to 9, characterized in that the fourth shoe member (44) consists of a lath about 40 to 70 mm in width.

AMENDED CLAIMS

[received by the International Bureau on 18 June 1986 (18.06.86): original claims 1–10 replaced by new claims 1–9 (3 pages)]

1. Upper wire unit (30), with ancillary equipment (41,43,45), for remodelling the Fourdrinier wire section of a paper machine, said unit (30) comprising a frame structure (35) and an upper wire (31) loop guided by guide rolls (32,33,34) mounted on its support, whereof one is a breast roll (32), and by stationary shoe members this loop cooperating with the loop of the lower wire (11) belonging to said Fourdrinier wire section on a part (L) of this lower wire loop's length (L_o) so that the upper wire loop (31) and the lower wire loop (11) have a joint run, in the region of which water is drained from the water-containing fibre course (W_o) conducted in between said wires (11,31), which has been formed on the initial part (11a) of the lower wire (11) before said joint run, both predominantly through the upper wire (31) and through the lower wire (11) substantially by utilizing stationary shoe members (41,42,43,44, 45,46'), of which part have been disposed inside the upper wire loop (31) and another part inside the lower wire loop (11), of said shoe members (41,42,43,44,45) those having an odd ordinal number as counted in the direction of travel of the wires being placed inside the lower wire loop (11), respectively those with even number, inside the upper wire loop (31), the joint run of said upper and lower wire loops (11,31) begins in the region of said first shoe member (41) and that the line (K_1) at the solid cover of the first shoe member (41) where the upper wire (31) and the lower wire (11) are tangent to each other has been arranged to be preferably adjustable by raising or lowering (S) the breast roll (32) or equivalent member of the upper wire (31) in order to control the quantity of the dewatering taking place by effect of the first solid shoe member (41) through the upper wire (31), said shoe members (41,42,43,44,45) and equivalent (46) in the twin-wire (11,31) forming zone have been preferably disposed with substantially uniform horizontal spacing after each other and so located in the height direction that the twin-wire part is by effect of said shoe members guided to run below the original plane (T-T) of the planar wire section's upper run along a substantially sinusoidal undulating path, c h a r a c t e r i z e d in that the ratio of the wavelength λ of said undulating path to the amplitude

H of the wave is in the range λ/H = 10 to 25, preferably λ/H = 12 to 20, and that said wavelength λ is in the range λ = 500 to 1000 mm and said amplitude H is in the range H = 35 to 60 mm, preferably H = 40 to 50 mm.

2. Upper wire unit according to claim 1, characterized in that the adjustment of the line of contact (K_1) between the upper and lower wires (11,31) requisite for controlling the quantity of dewatering taking place in the region of the first solid-cover shoe (41) has been totally or partly provided for by adjusting the transversal tilt, in relation to the direction of travel of the wire (11), of said shoe member and/or the position in height and/or the lateral position of said shoe member (41).

3. Upper wire unit according to claim 1 or 2, characterized in that the breadth (L_{10}) in the direction of travel of the wires (11,31) of the first shoe member (41) is in the range L_{10} = 300 to 500 mm.

4. Upper wire unit according to any one of claims 1 to 3, characterized in that said second shoe member (42) consists of at least one lath of width about 50 to 100 mm.

5. Upper wire unit according to any one of claims 1 to 4, characterized in that said second shoe member (42) has been connected to a water collection passage (46), which is upwardly inclined in relation to the direction of travel of the wires, and to a water removal means (40).

6. Upper wire unit according to any one of claims 1 to 5, characterized in that the fourth shoe member (44) consists of a lath about 40 to 70 mm in width.

7. Upper wire unit according to any one of claims 1 to 5, characterized in that the length of the twin-wire zone is greater than the length of one whole wave (λ).

8. Upper wire unit according to claim 7, characterized

in that the length of the twin-wire zone is about the length of two whole waves (2 x λ).

9. Upper wire unit according to any one of claims 1 to 8, c h a r a c t e r i z e d in that the parameters of the unit have been selected so that the contribution of the dewatering taking place through the upper wire (31) by effect of the first solid shoe member (41) to the dewatering taking place in the twin-wire forming zone (L) is in the order of about 85 to 95 %, preferably about 90 %.

M 16.02.94

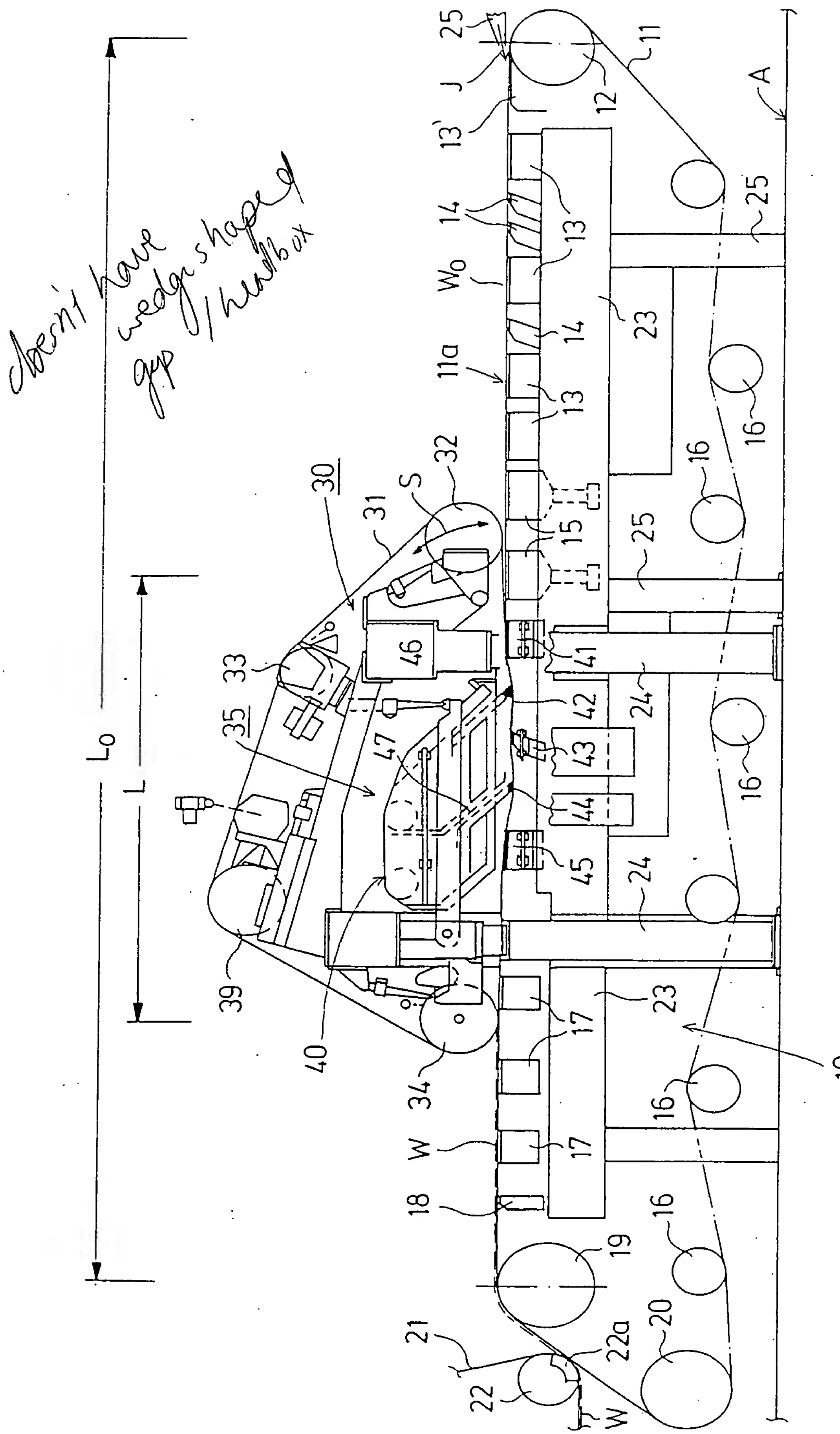
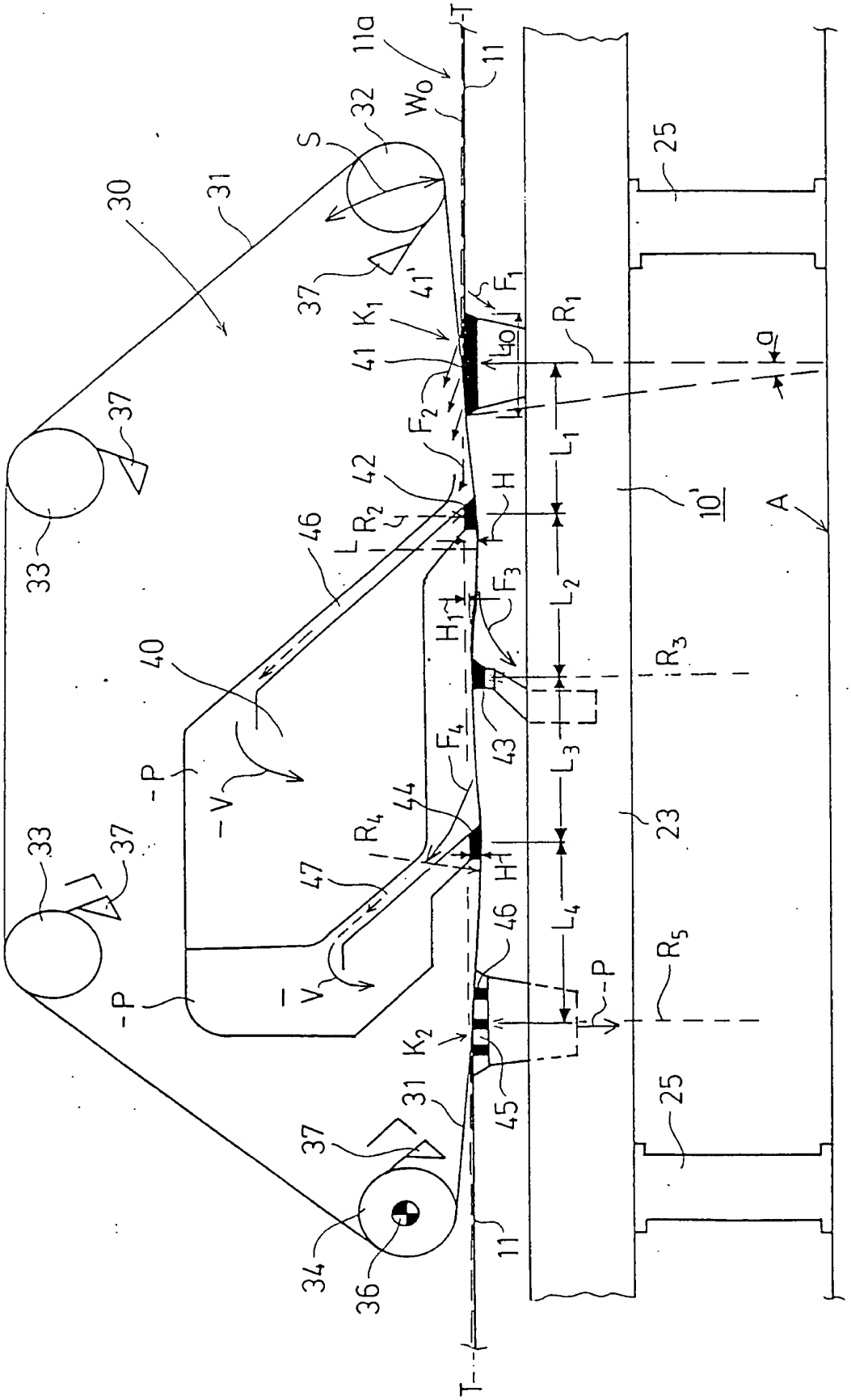


FIG. 1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42
R_2
H
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L
L_2
F_3
H_1
40
R_3
10'
A
-P
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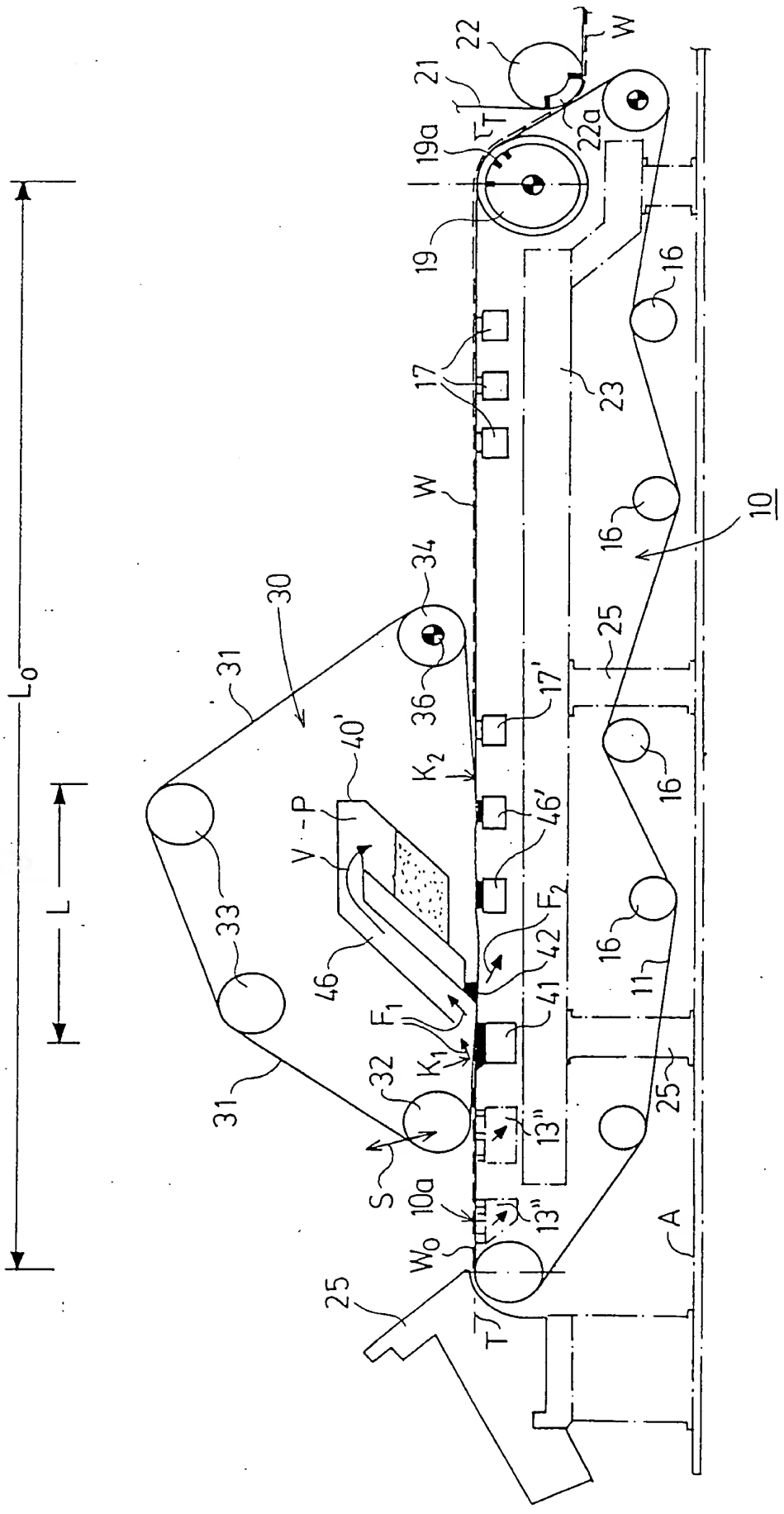
FIG. 2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42
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46'
V-P
F1
F2
K1
K2
13"

FIG.3

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI86/00012

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

D 21 F 1/00, 9/00, 11/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	D 21 F 1/00, 9/00, 11/00
US Cl	162:300, 301

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	DE, A1, 3 306 717 (VALMET OY) 8 September 1983 & DE, 3204465 SE, 8200727 CA, 1170881	1
A	DE, A1, 3 315 023 (VALMET OY) 10 November 1983	1
P	GB, A, 2 143 871 (BELOIT WALMSLEY LIMITED) 20 February 1985	1,5
X	US, A, 4 472 244 (VALMET OY) 18 September 1984	1-5

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1986-04-24	1986 -04- 29
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Olov Jensén

MJ

Form PCT/ISA/210 (second sheet) (January 1985)